AMENDMENTS TO THE CLAIMS:

This listing of the claims will replace all prior versions, and listings, of the claims in this application.

Listing of Claims:

1. (Currently Amended) A code division, multiple access (CDMA) receiver, comprising a receiver input for coupling to signal outputs of N_{rx} receive antennas, the signal outputs being sampled at N_s samples per symbol or chip, a matched filter, and a whitening filter system for coupling the receiver input to an input of the matched filter, said whitening filter system comprising N_sN_{rx} parallel individual whitening filters $\mathbf{w}_{j,k}$, individual whitening filters $\mathbf{w}_{j,k}$ receiving, during each symbol interval *I,* N_sN_{rx} new signal samples via a signal connection matrix such that a first individual whitening filter receives one of the new samples, a second individual whitening filter receives the same new sample as the first individual whitening filter, and one additional new sample, and such that an *n*th individual whitening filter receives the same *n*-1 new samples as the first *n*-1 individual whitening filters, plus one additional new sample, said whitening filter system comprising N_{rx} outputs for outputting filtered signal samples such that a filtered signal sample appearing in the N_{rx} outputs does not correlate with any other filtered signal sample appearing in N_{rx} outputs.

2. (Original) A CDMA receiver as in claim 1, further comprising a delay line comprised of a plurality of serially coupled delay line elements each having a delay of one symbol interval, said delay line having an input coupled to an output of said signal connection matrix and providing the N_sN_{rx} parallel whitening filters $\mathbf{w}_{j,k}$ with delayed versions of said signal samples.

3. (Original) A CDMA receiver as in claim 2, where for a symbol interval *i* and where $N_sN_{rx}=4$, signal vectors output from the delay line elements are defined as:

$$\mathbf{r}(i-1)=\begin{pmatrix} r_{1,1}(i-1) \\ r_{1,2}(i-1) \\ r_{2,1}(i-1) \\ r_{2,2}(i-1) \end{pmatrix},$$

where in the term $r_{n,m}(i)$ the symbols n and m denote an antenna and a symbol sample index, respectively, where an the input signal vector for an arbitrary one of the individual whitening filters $\mathbf{w}_{n,m}$ is denoted by $\mathbf{r}_{n,m}$, the signal connection matrix results in input signal vectors:

$$\mathbf{r}_{1,1}(i)=\begin{pmatrix} \vdots \\ \mathbf{r}(i-2) \\ \mathbf{r}(i-1) \\ r_{1,1}(i) \end{pmatrix} ;\mathbf{r}_{1,2}(i)=\begin{pmatrix} \vdots \\ \mathbf{r}(i-2) \\ \mathbf{r}(i-1) \\ r_{1,1}(i) \\ r_{1,2}(i) \end{pmatrix} ;\mathbf{r}_{2,1}(i)=\begin{pmatrix} \vdots \\ \mathbf{r}(i-2) \\ \mathbf{r}(i-1) \\ r_{1,1}(i) \\ r_{1,2}(i) \\ r_{2,1}(i) \end{pmatrix} ;\mathbf{r}_{2,2}(i)=\begin{pmatrix} \vdots \\ \mathbf{r}(i-2) \\ \mathbf{r}(i-1) \\ \mathbf{r}(i) \end{pmatrix}$$

at the inputs to the individual whitening filters $\mathbf{w}_{n,m}$.

4. (Original) A CDMA receiver as in claim 3, where in a direct form solution, taking one of the signal vectors the signal model is expressed as

$$\mathbf{r}_{n,m}(i)=\mathbf{Gb}+\mathbf{n}=\begin{pmatrix} \mathbf{H} \\ \mathbf{h}^T \end{pmatrix}\mathbf{b}+\mathbf{n},$$

where $(\cdot)^T$ denotes transposition, $\mathbf{G}$ is a channel matrix, possibly including the effect of transmitter and receiver filters, $\mathbf{b}$ is a symbol vector and $\mathbf{n}$ a noise vector, and vector $\mathbf{h}^T$ is the bottom row of $\mathbf{G}$, the corresponding individual whitening filter $\mathbf{w}_{n,m}$ output is

$$g_{n,m}(i)=\mathbf{w}_{n,m}^H(i)\mathbf{r}_{n,m}(i),$$

where $(\cdot)^H$ denotes conjugate transposition.

5. (Original) A CDMA receiver as in claim 4, where an individual whitening filter $\mathbf{w}_{n,m}$ is obtained by using linear minimum mean-square error (LMMSE) criterion as

$$\mathbf{w}_{n,m}(i) = \begin{pmatrix} -\alpha \mathbf{C}_{n,m}^{-1} \mathbf{H} \mathbf{h}^{*} \\ 1 \end{pmatrix} = \begin{pmatrix} -\mathbf{u}_{n,m} \\ 1 \end{pmatrix},$$

in which $(\cdot)^{-1}$ denotes matrix inversion and $(\cdot)^{*}$ complex conjugation, where symbol α is a real scaling factor, and the covariance matrix of $\mathbf{r}_{n,m}(i)$ is

$$\mathbf{C}_{n,m} = \text{Expectation}\{\tilde{\mathbf{r}}_{n,m}(i)\tilde{\mathbf{r}}_{n,m}^{H}(i)\},$$

where the tilde above vector $\mathbf{r}_{n,m}(i)$ denotes an operation where the bottom element of the original vector is excluded.

6. (Original) A CDMA receiver as in claim 5, where the unfixed part $\mathbf{u}_{n,m}$ of the whitening filter is made adaptive in accordance with:

$$\mathbf{u}_{n,m} \leftarrow \mathbf{u}_{n,m} + \mu\{g_{n,m}^{*}(i)\tilde{\mathbf{r}}_{n,m}(i)\},$$

where parameter μ is a step size factor.

7. (Currently Amended) A CDMA receiver as in claim 1, where said whitening filter <u>system comprises</u> ~~is implemented using~~ serially coupled lattice stages that form a lattice filter.

8. (Currently Amended) A method for operating a code division, multiple access (CDMA) receiver, comprising:

coupling a receiver input to signal outputs of N_{rx} receive antennas, the signal outputs being sampled at N_s samples per symbol,

whitening the signal outputs; and

filtering the whitened signal outputs with a matched filter, where

whitening uses a whitening filter system comprising N_sN_{rx} parallel individual whitening filters $\mathbf{w}_{j,k}$, individual whitening filters $\mathbf{w}_{j,k}$ receiving during each symbol interval i, N_sN_{rx} new signal samples via a signal connection matrix such that a first individual whitening filter receives only one of the new samples, a second individual whitening filter receives the same sample as the first individual whitening filter, and one additional sample, and such that an nth individual whitening filter receives the same n-1 samples as the first n-1 individual whitening filters, plus one of the remaining samples, and outputting from said whitening filter system, over N_{rx} outputs, filtered signal samples such that a filtered signal sample appearing in the N_{rx} outputs does not correlate with any other filtered signal sample appearing in N_{rx} outputs.

9. (Original) A method as in claim 8, further comprising operating a delay line comprised of a plurality of serially coupled delay line elements each having a delay of one symbol interval, said delay line having an input coupled to an output of said signal connection matrix and providing the N_sN_{rx} parallel whitening filters $\mathbf{w}_{j,k}$ with delayed versions of said signal samples.

10. (Original) A method as in claim 9, where for a symbol interval i and where $N_sN_{rx}=4$, signal vectors output from the delay line elements are defined as:

$$\mathbf{r}(i-1)=\begin{pmatrix} r_{1,1}(i-1) \\ r_{1,2}(i-1) \\ r_{2,1}(i-1) \\ r_{2,2}(i-1) \end{pmatrix},$$

where in the term $r_{n,m}(i)$ the symbols n and m denote an antenna and a symbol sample index, respectively, where an the input signal vector for an arbitrary one of the individual whitening filters $\mathbf{w}_{n,m}$ is denoted by $\mathbf{r}_{n,m}$, the signal connection matrix results in input signal vectors:

$$\mathbf{r}_{1,1}(i)=\begin{pmatrix}\vdots\\ \mathbf{r}(i-2)\\ \mathbf{r}(i-1)\\ r_{1,1}(i)\end{pmatrix};\mathbf{r}_{1,2}(i)=\begin{pmatrix}\vdots\\ \mathbf{r}(i-2)\\ \mathbf{r}(i-1)\\ r_{1,1}(i)\\ r_{1,2}(i)\end{pmatrix};\mathbf{r}_{2,1}(i)=\begin{pmatrix}\vdots\\ \mathbf{r}(i-2)\\ \mathbf{r}(i-1)\\ r_{1,1}(i)\\ r_{1,2}(i)\\ r_{2,1}(i)\end{pmatrix};\mathbf{r}_{2,2}(i)=\begin{pmatrix}\vdots\\ \mathbf{r}(i-2)\\ \mathbf{r}(i-1)\\ \mathbf{r}(i)\end{pmatrix}$$

at the inputs to the individual whitening filters $\mathbf{w}_{n,m}$.

11. (Original) A method as in claim 10, where in a direct form solution, taking one of the signal vectors the signal model is expressed as

$$\mathbf{r}_{n,m}(i)=\mathbf{G}\mathbf{b}+\mathbf{n}=\begin{pmatrix}\mathbf{H}\\ \mathbf{h}^T\end{pmatrix}\mathbf{b}+\mathbf{n},$$

where $(\cdot)^T$ denotes transposition, $\mathbf{G}$ is a channel matrix, possibly including the effect of transmitter and receiver filters, $\mathbf{b}$ is a symbol vector and $\mathbf{n}$ a noise vector, and vector $\mathbf{h}^T$ is the bottom row of $\mathbf{G}$, the corresponding individual whitening filter $\mathbf{w}_{n,m}$ output is

$$g_{n,m}(i)=\mathbf{w}^H_{n,m}(i)\mathbf{r}_{n,m}(i),$$

where $(\cdot)^H$ denotes conjugate transposition.

12. (Original)A method as in claim 11, where an individual whitening filter $\mathbf{w}_{n,m}$ is obtained by using linear minimum mean-square error (LMMSE) criterion as

$$\mathbf{w}_{n,m}(i) = \begin{pmatrix} -\alpha \mathbf{C}_{n,m}^{-1}\mathbf{H}\mathbf{h}^{*} \\ 1 \end{pmatrix} = \begin{pmatrix} -\mathbf{u}_{n,m} \\ 1 \end{pmatrix},$$

in which $(\cdot)^{-1}$ denotes matrix inversion and $(\cdot)^{*}$ complex conjugation, where symbol α is a real scaling factor, and the covariance matrix of $\mathbf{r}_{n,m}(i)$ is

$$\mathbf{C}_{n,m} = \text{Expectation}\left\{\tilde{\mathbf{r}}_{n,m}(i)\tilde{\mathbf{r}}_{n,m}^{H}(i)\right\},$$

where the tilde above vector $\mathbf{r}_{n,m}(i)$ denotes an operation where the bottom element of the original vector is excluded.

13. (Original) A method as in claim 12, where the unfixed part $\mathbf{u}_{n,m}$ of the whitening filter is made adaptive in accordance with:

$$\mathbf{u}_{n,m} \leftarrow \mathbf{u}_{n,m} + \mu\left\{g_{n,m}^{*}(i)\tilde{\mathbf{r}}_{n,m}(i)\right\},$$

where parameter μ is a step size factor.

14. (Currently Amended) A method as in claim ~~7~~ 8, where said whitening filter system comprises ~~is implemented using~~ serially coupled lattice stages that form a lattice filter.

15. (Currently Amended) A code division, multiple access (CDMA) mobile station, said mobile station comprising a receiver coupled to N_{rx} receive antennas and further comprising baseband circuitry for sampling signal outputs of said N_{rx} receive antennas at N_s samples per symbol or chip, said baseband circuitry further comprising a multi-antenna RAKE receiver and a whitening filter system for coupling the sampled signals to inputs of said multi-antenna RAKE receiver, said whitening filter system comprising N_sN_{rx} parallel individual whitening filters $\mathbf{w}_{j,k}$, individual whitening filters $\mathbf{w}_{j,k}$ receiving, during each symbol interval I, N_sN_{rx} new signal samples via a signal connection matrix such that a first individual whitening filter receives one of the new

samples, a second individual whitening filter receives the same new sample as the first individual whitening filter, and one additional new sample, and such that an *n*th individual whitening filter receives the same *n*-1 new samples as the first *n*-1 individual whitening filters, plus one additional new sample, further comprising a delay line comprised of a plurality of serially coupled delay line elements each having a delay of one symbol interval, said delay line having an input coupled to an output of said signal connection matrix and providing the N_sN_{rx} parallel <u>individual</u> whitening filters $\mathbf{w}_{j,k}$ with delayed versions of said signal samples, said whitening filter <u>system</u> comprising N_{rx} outputs for outputting whitened filtered signal samples to said multi-antenna RAKE receiver.

16. (Currently Amended) A CDMA mobile station as in claim 15, where said whitening filter and said multi-antenna RAKE receiver together comprise a linear ~~(minimum mean-square error)~~ channel equalizer.

17. (Currently Amended) A CDMA mobile station as in claim 15, where said whitening filter <u>system</u> and said multi-antenna RAKE receiver together comprise a multi-antenna space-time equalizer that ~~optimally~~ performs beam-forming while suppressing inter-cell interference.

18. (Currently Amended) A CDMA mobile station as in claim 15, where said same whitening filter <u>system</u> is used for receiving transmissions from a plurality of base stations during a soft handoff procedure.

19. (New) A CDMA mobile station as in claim 16, where said linear channel equalizer is comprised of a minimum mean-square error channel equalizer.

20. (New) A circuit, comprising an input for coupling to signal outputs of N_{rx} receive antennas, means for sampling the signal outputs at N_s samples per symbol or chip, matched filter means and whitening filter means for coupling the receiver input to an input of the matched filter means, said whitening filter means comprising N_sN_{rx} parallel individual whitening filters $\mathbf{w}_{j,k}$, individual whitening filters $\mathbf{w}_{j,k}$ receiving, during each symbol interval *I*, N_sN_{rx} new signal samples such that

a first individual whitening filter receives one of the new samples, a second individual whitening filter receives the same new sample as the first individual whitening filter, and one additional new sample, and such that an *n*th individual whitening filter receives the same *n*-1 new samples as the first *n*-1 individual whitening filters, plus one additional new sample, said whitening filter means comprising N_{rx} outputs for outputting filtered signal samples such that a filtered signal sample appearing in the N_{rx} outputs does not correlate with any other filtered signal sample appearing in N_{rx} outputs.

21. (New) A circuit as in claim 20, further comprising delay means comprised of a plurality of delay elements for providing the N_sN_{rx} parallel whitening filters $\mathbf{w}_{j,k}$ with delayed versions of said signal samples.

22. (New) A circuit as in claim 20, where said whitening filter means comprises serially coupled lattice stages that form lattice filter means.

23. (New) A computer program product comprising instructions operable for whitening a signal, comprising operations of:

operating on sampled signal outputs of N_{rx} receive antennas, where the signal outputs are sampled at N_s samples per symbol, for whitening the signal outputs, where whitening uses a whitening filter system comprising N_sN_{rx} parallel whitening filters $\mathbf{w}_{j,k}$, individual whitening filters $\mathbf{w}_{j,k}$ receiving during each symbol interval *i*, N_sN_{rx} new signal samples such that a first individual whitening filter receives only one of the new samples, a second individual whitening filter receives the same sample as the first individual whitening filter, and one additional sample, and such that an *n*th individual whitening filter receives the same *n*-1 samples as the first *n*-1 individual whitening filters, plus one of the remaining samples, and outputting from said whitening filter system, over N_{rx} outputs, filtered signal samples such that a filtered signal sample appearing in the N_{rx} outputs does not correlate with another filtered signal sample appearing in N_{rx} outputs.

24. (New) A computer program product as in claim 23, further comprising operations of providing the N_sN_{rx} parallel whitening filters $\mathbf{w}_{j,k}$ with delayed versions of said signal samples.